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(56) Documents cited  
GB 1523129 A EP 0334824 A EP 0295351 A  
US 4665304 A US 4665302 A

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## (54) Heater assembly for mirrors

(57) A heater assembly suitable for attachment to the rear surface of a mirror 1 comprises a flexible support member 2 bearing a heating element 3 (shown in the form of a sinuous strip, though other forms are possible) and having an integral flexible extension of ribbon form 4 which bears lead-in conductors 5 for the heating element 3 and terminals 6 for connecting current supply lines within a cable 7 to such lead-in conductors. Support 2 may be a polyester foil upon which the conductors are printed or two foils between which the conductors are located. In this way the terminals 6 are movable with respect to the mirror. A temperature sensor 10 may be provided for regulating the supply of heat current. Such mirrors are useful as externally mounted rear-view mirrors of motor vehicles.

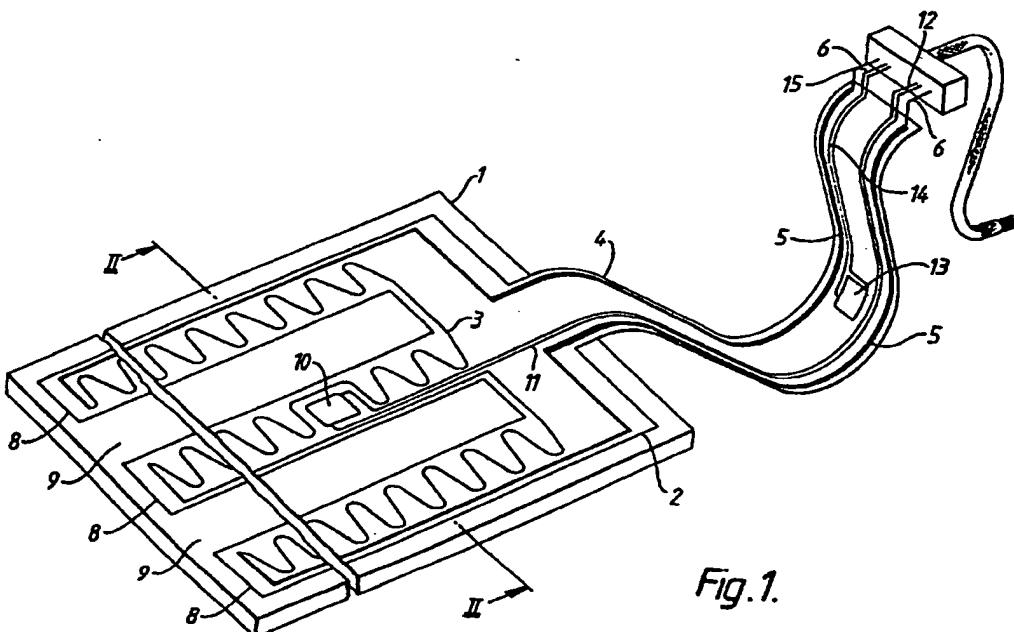
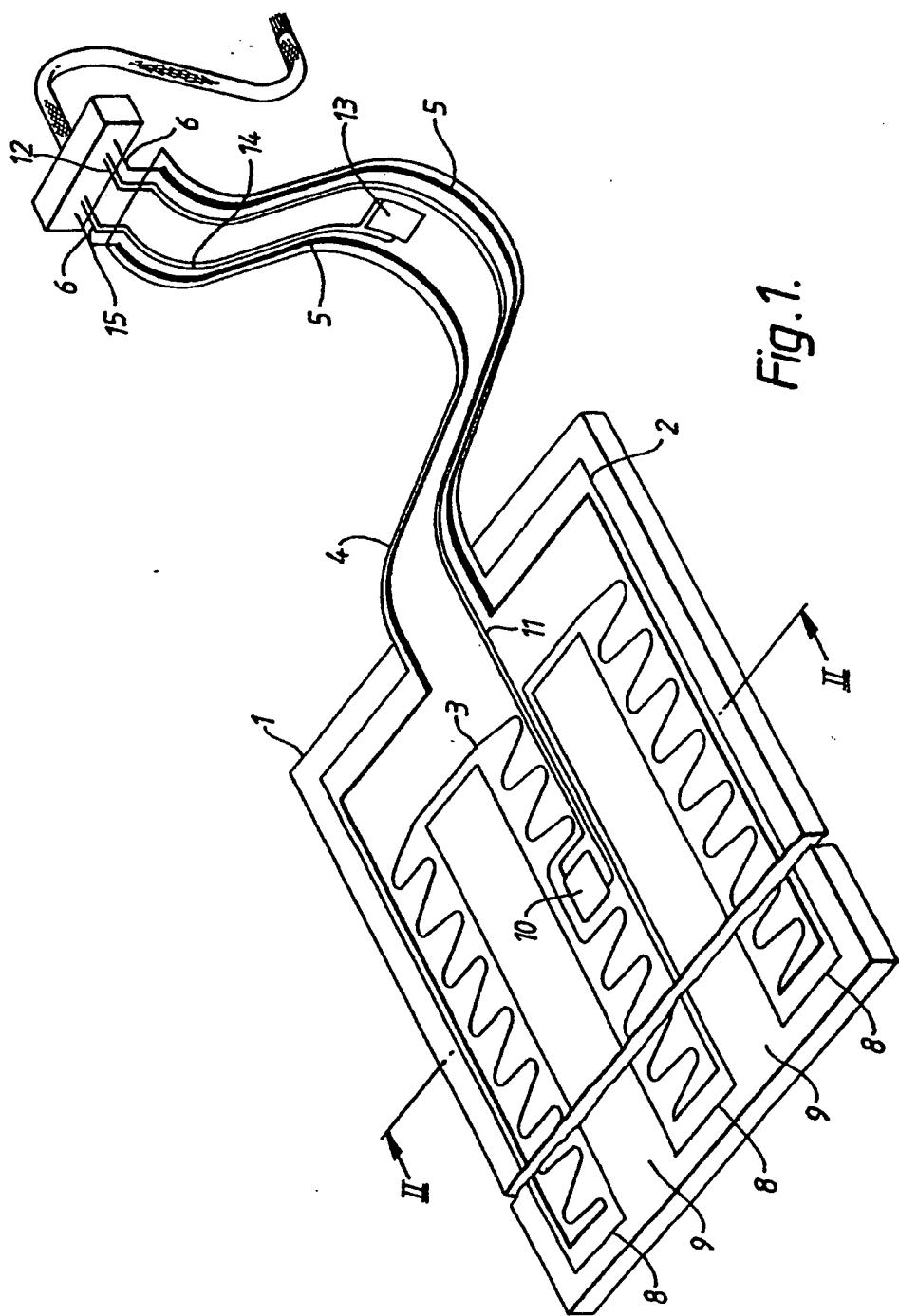


Fig. 1.

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

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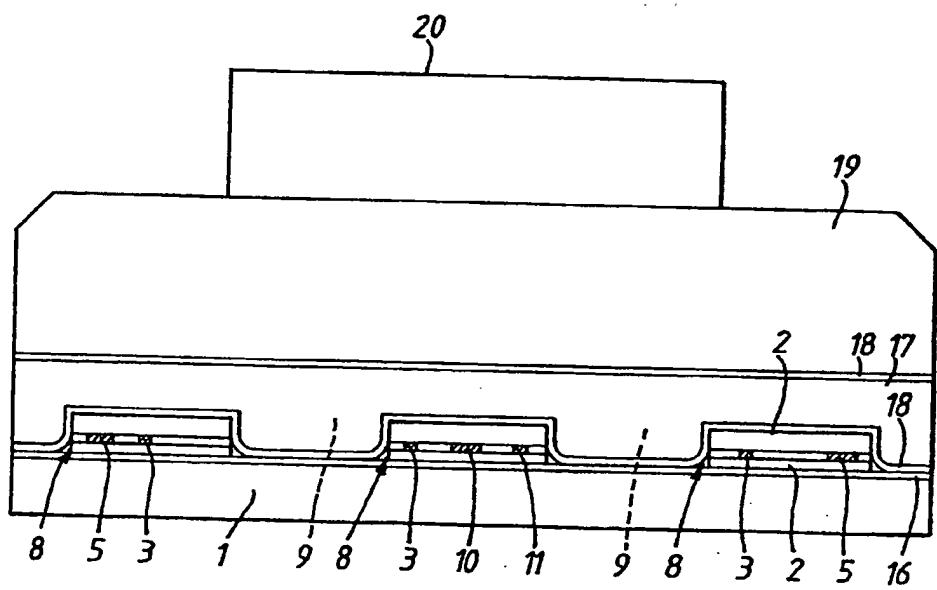


Fig. 2.

### HEATER ASSEMBLY FOR MIRRORS

This invention relates to heatable mirrors, and in particular to a heater assembly suitable for attachment to the rear face of a mirror.

Heatable mirrors may be used for example in bathrooms, in order

- 5 to inhibit condensation of water vapour on the mirror, but they are perhaps more widely used as rear view mirrors for motor vehicles, especially as rear view mirrors mounted on the exterior of the vehicle, whether on one or both front wings or, as is the more usual modern practice, on the front doors of the vehicle, again to inhibit condensation,
- 10 to evaporate rainwater, and to perform a de-icing function in winter.

Such mirrors are of course known. Such a mirror may be flat or curved, and it may be formed in the classical way by applying successive layers of silver, copper and protective paint. The reflective surface may alternatively be applied by vacuum deposition. For

- 15 example a mirror with a front reflective surface may be formed by the vacuum deposition of chromium overcoated with an interference coating of titanium dioxide. The mirror may alternatively be formed as an anti-glare mirror, the reflective properties being afforded an electrochromic cell or by a liquid crystal disposed over the whole front
- 20 face of the mirror, the liquid crystal being controllable to vary the reflective power of the mirror in order to reduce glare from the headlights of a following vehicle. It is known that such mirrors may not be allowed to become too cold or functioning of the liquid crystal will be impaired. In many of such mirrors, the heat energy required is
- 25 supplied by a resistance heater. Such a resistance heater may be constituted by a heating element formed on a support which is attached to the rear face of the mirror, the heating element being printed or otherwise applied to the support (e.g. by a serigraphic process or as a network of wires bonded to the support). Alternatively, such a heater
- 30 may be constituted by a conductive coating or a network of wires applied to the mirror itself.

Obviously current must be supplied to such heating element, and it

is in the supply of such current that the problem with which this invention is concerned lies. Such mirrors are supplied with their heating element and with terminals for connexion to current supply wires. In practice, the terminals are located at an edge of the mirror to

5      simplify the attachment of the current supply wires, whether by soldering, riveting or simply push-fitting, and they must be bonded firmly to it in order to withstand the forces involved when a current supply wire is affixed to the terminal. However, there is a local increase in the thickness of the mirror due to the presence of such a

10     terminal, which may of itself be inconvenient, especially in cases where the mirror is to be bonded to a support, since the thickness irregularity may be sufficient to spoil the bond between the mirror and its support at that region so allowing the ingress of moisture between the mirror and its support. This would lead in time to the degradation of the bond

15     between the mirror and its support so that the mirror would be less able to resist mechanical shock or forces tending to separate it from the support. Also, we have found that there is a risk that the heating circuitry in the region of such a terminal may peel away from the mirror, and this will allow the ingress of humidity which will lead to

20     corrosion and thus deterioration of the heater, and it will also lead to corrosion and thus deterioration of a reflective surface applied to the rear of the mirror.

It is an object of the present invention to provide a heatable mirror assembly and a heater assembly for attachment to the rear face of a

25     mirror which allows this disadvantage to be alleviated.

According to the invention, there is provided a heatable mirror assembly which comprises a mirror and secured to the rear surface thereof a heater assembly which comprises a flexible support member bearing a heating element and having an integral flexible extension of

30     ribbon form which bears lead-in conductors for the heating element and terminals for connecting current supply lines to such lead-in conductors, whereby the terminals are movable with respect to the mirror.

Because the terminals are located on the extension ribbon and thus movable with respect to the mirror, they may be held independently of the mirror during connexion of current supply wires, there need be no significant local thickening of the mirror assembly near its margin, and

5 as a consequence of this, or possibly for some other reason, we have noted that there is a reduced risk that degradation of the mirror assembly will be initiated where the lead-in conductors pass over the margin of the mirror. Furthermore, such terminals are more easily manipulable than terminals made fast to a mirror, and this simplifies

10 connexion of the current supply lines.

The present invention also extends to a heater assembly suitable for attachment to the rear surface of a mirror which comprises a flexible support member bearing a heating element and having an integral flexible extension of ribbon form which bears lead-in conductors for the

15 heating element and terminals for connecting current supply lines to such lead-in conductors.

Such a heater assembly is eminently adapted for incorporation into a heatable mirror assembly in accordance with this invention. It is simple to manufacture and is easily stored and transported, for example

20 to mirror manufacturers, or to others, such as vehicle manufacturers, who also have a supply of mirrors.

Advantageously, said flexible support is provided by a polyester foil. Such supports are inexpensive and simple to manufacture, they are long-lasting, and they are well adapted to receive heating elements.

25 Also, such a support is easily cut to size and shape to match a wide variety of mirror sizes and shapes. Also they are easily bonded by adhesive to the rear face of a mirror. Such a support member may be formed from a condensation product of ethylene glycol and terephthalic acid such as "MYLAR"™.

30 The heating element may be constituted by a wire bonded to or embedded in the flexible support, but preferably, said heating element is printed onto said flexible support member. This has advantages in ease

of manufacture in large scale production, and also in allowing the avoidance of irregularities in the thickness of the heater assembly, particularly since such a printed heating element need be no more than 100  $\mu\text{m}$  in thickness.

5 In some preferred embodiments of the invention, said flexible support member carries a temperature sensor for sensing the temperature of the mirror. Such a temperature sensor may be used for regulating the supply of heating current to the mirror, in order to avoid over-heating of the mirror, or simply to save unnecessary use of heating  
10 current.

Such a temperature sensor may be formed by photo-etching of a metallic ribbon or coating, for example by two thin layers of metal arranged to form a thermocouple. Such a sensor may thus also be very thin so that significant local thicknesses on the rear face of the mirror  
15 assembly are avoided.

In some preferred embodiments of the invention, primarily intended for use in external mirror assemblies of motor vehicles, such ribbon extension carries a temperature sensor. This temperature sensor may be present as an alternative, or in addition, to a temperature sensor  
20 for sensing the temperature of the mirror located on the heating element support. Such a ribbon temperature sensor can be used to derive a signal corresponding to the external ambient temperature, and that signal may also be used for controlling the supply of heating current to the heater assembly. Alternatively, or in addition, such a signal could  
25 be fed to display means to give a visible indication of the external temperature.

Such display means could be located on a vehicle dashboard or elsewhere. In some preferred embodiments of the invention, the mirror incorporates liquid crystal display elements for displaying an indication  
30 of the temperature sensed by the sensor on the ribbon extension. This has the advantage of avoiding the necessity for providing lengthy electrical connexions to the display means, and it also allows the

provision of a simple and compact accessory which may be installed in a motor vehicle easily and quickly, and, provided that there is already a current supply to an external mirror mounting, without any modification to the vehicles electrical system.

5        In the most preferred embodiments of the invention, said flexible support member is constituted as a laminate of two foils with the electrical components sandwiched between them. This has the advantage of protecting those conductive elements after manufacture of the heater assembly and before it is incorporated into the mirror 10 assembly. An alternative and less expensive way of protecting the conductive elements is to overcoat them with a varnish after they have been applied to a said flexible support member, as may also be preferred.

15      The length of the ribbon extension is not particularly critical. It should be long enough that the extension and the terminals carried thereby can be held for the connexion of current supply lines, but it should not be so long that it presents difficulties in stowage in a mirror housing or frame. It is accordingly preferred that such ribbon extension be between 5 and 20 centimetres in length.

20      In accordance with the invention, the heater assembly is to be secured to the rear face of a mirror. This will ensure the necessary thermal contact between the heating element and the mirror for the purposes in view. There are various ways in which such securing could be effected, for example a liquid adhesive could be used, as it is 25 in many preferred embodiments.

In some preferred embodiments, the heater assembly is secured to the mirror by means of an adhesive sheet. This facilitates manufacture.

By way of example, a thin plastics foil coated with adhesive on both its main faces could be assembled between the mirror and the 30 heater assembly. Such foil is commercially available as "Double-Sided Sellotape"™.

It is preferred, however, that the heater assembly is discontinuous over the area of the mirror and the adhesive sheet is bonded to the heater assembly and to the rear of the mirror at such discontinuity or discontinuities. This may provide economic advantages as will be 5 adverted to below, and it also allows other advantages to be obtained. By virtue of the adoption of this preferred feature of the invention, the mirror itself is directly bonded to the adhesive backing sheet, and this relieves tensile forces acting through the thickness of the heater support so reducing any risk that that support will become delaminated or 10 otherwise deteriorate. Thus the adoption of this preferred feature allows a longer life to the heater support and provides a better bond between the mirror itself and the backing sheet, especially when, as is preferred, the discontinuous heater support is also glued to the rear of the mirror, so that the mirror is better able to withstand the effects of 15 vibration to which it would be subjected if it were mounted, for example, to a motor vehicle.

This is considered to be of particular importance in practice, since motor vehicle mirrors are often required to be able to withstand a force of 200 N applied to their centre to pull them away from their support, 20 and the achievement of this advantage does not depend in its entirety on the presence of a flexible ribbon extension of the heater assembly support. Accordingly, in its second aspect, this invention also provides a heatable mirror assembly which comprises a mirror and secured to the rear surface thereof a heater assembly which comprises a support 25 member bearing a heating element which support member is discontinuous over the area of the mirror and is secured to the mirror by means of an adhesive sheet, the adhesive sheet being bonded to the heater assembly and to the rear of the mirror at such discontinuity or discontinuities.

30 It is most convenient, and therefore preferred that the flexible support member is provided with re-entrants in its profile and/or with perforations to give such a discontinuity or discontinuities.

The provision of such a discontinuity or discontinuities allows the heater assembly to be secured to the mirror by an adhesive backing sheet, such as a standard, single-sided adhesive foil, for example single-sided "Sellotape"™, which is less expensive than double-sided foil. Alternatively, it permits the mirror and heater assembly to be bonded to a backing element using only a single piece of double-sided adhesive sheet.

Advantageously, the mirror and heater assembly are secured to a substantially rigid support. Such a support provides strength to the mirror, and can readily be adapted to facilitate mounting of the mirror in any desired location.

Preferably, such rigid support is bonded to the heater and mirror by means of a sheet of foam material coated with adhesive on both main faces. A suitable adhesive sheet is commercially available in the form of polystyrene foam sheeting about 1 to 1.5 mm thick which is coated with a contact adhesive on both sides. The use of such a foam sheet allows its adhesive surfaces to conform to the mirror and to the heater assembly because the adhesive surface next to the mirror assembly can accommodate the discontinuity or discontinuities in the heater support member. It further allows equalisation of stresses tending to separate the mirror from the substantially rigid support, thus increasing the strength and the useful life of the product.

The invention has been made with particular, but not exclusive, reference to the rear view mirrors of motor vehicles. It is generally a requirement that such mirrors be adjustable in orientation in their mountings in order to allow for different positions of a driver's head in relation to the mirror. In order to accommodate such adjustment, it is therefore preferred that such substantially rigid support carries one element of a universal joint. Such universal joint element can co-operate with a complementary universal joint element fixed within a mirror housing so that the orientation of the mirror can be changed.

In some such preferred embodiments of the invention, said

substantially rigid support carries means for co-operating with a mirror adjustment mechanism. Such mechanisms, whether manually or electrically operable, are commonly provided on modern motor vehicles.

5 A preferred embodiment of the invention will now be described with reference to the accompanying diagrammatic drawings in which:

Figure 1 is a perspective view of a heater assembly laid up against the rear face of a mirror, and

Figure 2 is a cross-sectional view along the line II-II of the assembly of Figure 1 formed into a completed mirror assembly.

10 In Figure 1, heater assembly suitable for attachment to the rear surface of a mirror 1 comprises a flexible support member 2 bearing a heating element 3 (shown in the form of a sinuous strip, though other forms are possible) and having an integral flexible extension of ribbon form 4 which bears lead-in conductors 5 for the heating element 3 and  
15 terminals 6 for connecting current supply lines within a cable 7 to such lead-in conductors.

Such ribbon extension may be between 5 and 20 centimetres in length.

20 The flexible support member 2 is constituted by a polyester foil, suitably formed from a condensation product of ethylene glycol and terephthalic acid such as "MYLAR"™.

25 The flexible support member is of general E-shape so that it has three limbs 8 separated by re-entrants 9 in the profile of the heater support, and the support is of such size that a margin of the mirror 1 is left clear surrounding that support except where the integral flexible extension of ribbon form 4 leads away from the mirror.

30 The heating element and lead-in conductors are printed onto said flexible support member in a manner known per se, and they are suitably of copper. As shown in Figure 2, the flexible support member 2 may be constituted by two foils of polyester with the electrical conductors located between them. This has the additional advantage of protecting those conductive elements after manufacture of the

heater assembly and before it is incorporated into the mirror assembly. The whole laminate may suitably have a thickness of about 0.1 mm.

In addition, the central limb 8 of the heater support 2 carries a temperature sensor 10 for sensing the temperature of the mirror. Such 5 a temperature sensor may be used in a manner known per se for regulating the supply of heating current to the mirror, in order to avoid over-heating of the mirror, or simply to save unnecessary use of heating current. Connecting conductors 11 for that temperature sensor 10 may be printed onto the heater support 2 and extend along the ribbon 10 extension 4 to terminals 12.

The ribbon extension 4 carries a second temperature sensor 13. This second temperature sensor 13 may be present as an alternative, or in addition, to a temperature sensor such as 10 located on the heating element support for sensing the temperature of the mirror. Such 15 second temperature sensor 13 is provided with connecting conductors 14 printed onto the ribbon extension 4 and leading to terminals 15 for ultimate connexion to pass a signal corresponding to the external ambient temperature, which signal may be used for controlling the supply of heating current to the heater assembly. Alternatively, or in 20 addition, such a signal could be fed to display means to give a visible indication of the external temperature.

In a variant embodiment (not illustrated) the conductors 14 of the second temperature sensor 13 are connected to liquid crystal display means formed on the mirror 1 itself. Such a liquid crystal display unit 25 could be glued to the front face of the mirror, for example, at one corner. Alternatively, if the mirror were itself of the liquid crystal type, then a portion of the area of the mirror could be reserved for such a display.

Figure 2 shows a cross section through a completed mirror 30 assembly, in which the parts also shown in Figure 1 are allotted corresponding reference numerals. In Figure 2, a face of the heater assembly is coated with a liquid adhesive (not shown) and is laid up

against the rear face of the mirror 1 which is protected by a layer of paint 16. A sheet of polystyrene foam 17, each of whose faces is coated with adhesive 18 is then laid up against the heater and mirror so that it bonds to the limbs 8 of the heater assembly and to the painted 5 face of the mirror around its margin, and over the areas of the re-entrants 9 provided in the heater assembly. The rear face of the foam sheet 17 is bonded by adhesive 18 to a substantially rigid support member 19. The advantage of using a foam sheet such as 17 for bonding the mirror 1 to its substantially rigid support member 19 is that 10 the foam can accommodate itself to any slight irregularities in the space between the mirror and the support member, for example of about 0.1 mm, due to the local presence 8 or absence 9 of the heater. This enables the mirror better to resist forces tending to remove it from the support member 19. It is for example desirable that the mirror should 15 be able to withstand a force at its center of 200 N and forces of 50 N at any location around its edge.

The substantially rigid support member 19, which may for example be moulded from a high-impact plastics material is provided with means known per se and diagrammatically illustrated at 20 so that 20 it can be mounted as a rear view mirror in a housing attached for example to the door of a vehicle, the means 20 being arranged to co-operate with a mirror adjustment mechanism, whereby the orientation of the mirror may be adjusted about two axes from within the vehicle.

25 In a particular embodiment for use as a rear view mirror having a surface area of about  $150 \text{ cm}^2$ , the heater is arranged to dissipate 15 W when supplied from a 12 V power source. In the case of a mirror whose glass is 2 mm thick, this leads to a steady state mirror temperature in still air of 70°C.

30 Such a mirror may be flat or curved. In a variant, the heating element is formed by a more uniform coating rather than be a sinuous strip 3.

CLAIMS

1. A heatable mirror assembly which comprises a mirror and secured to the rear surface thereof a heater assembly which comprises a flexible support member bearing a heating element and having an integral flexible extension of ribbon form which bears lead-in conductors for the heating element and terminals for connecting current supply lines to such lead-in conductors, whereby the terminals are movable with respect to the mirror.
2. An assembly according to claim 1, wherein said flexible support member is constituted by a polyester foil.
3. An assembly according to claim 1 or 2, wherein said heating element is printed onto said flexible support member.
4. An assembly according to any preceding claim, wherein said flexible support member carries a temperature sensor for sensing the temperature of the mirror.
5. An assembly according to any preceding claim, wherein such ribbon extension carries a temperature sensor.
6. An assembly according to claim 5, wherein the mirror incorporates liquid crystal display elements for displaying an indication of the temperature sensed by the sensor on the ribbon extension.
7. An assembly according to any preceding claim, wherein such ribbon extension is between 5 and 20 centimetres in length.
8. An assembly according to any preceding claim, wherein said flexible support member is constituted as a laminate of two foils with the electrical components sandwiched between them.
9. An assembly according to any preceding claim, wherein the heater assembly is secured to the mirror by means of an adhesive sheet.
10. An assembly according to claim 9, wherein the heater assembly is discontinuous over the area of the mirror and the adhesive sheet is bonded to the heater assembly and to the rear of the mirror at such discontinuity or discontinuities.

11. A heatable mirror assembly which comprises a mirror and secured to the rear surface thereof a heater assembly which comprises a support member bearing a heating element which support member is discontinuous over the area of the mirror and is secured to the mirror by means of an adhesive sheet, the adhesive sheet being bonded to the heater assembly and to the rear of the mirror at such discontinuity or discontinuities.
12. An assembly according to claim 10 or 11, wherein one or more such discontinuities is provided by re-entrants in the profile of the flexible support member and/or by perforations through it.
13. An assembly according to any preceding claim, wherein the mirror and heater assembly are secured to a substantially rigid support.
14. An assembly according to claim 13 and any of claims 9 to 12, wherein such rigid support is bonded to the heater and mirror by means of a sheet of foam material coated with adhesive on both main faces.
15. An assembly according to claim 13 or 14, wherein such substantially rigid support carries one element of a universal joint.
16. An assembly according to claim 15, wherein said substantially rigid support carries means for co-operating with a mirror adjustment mechanism.
17. A heater assembly suitable for attachment to the rear surface of a mirror which comprises a flexible support member bearing a heating element and having an integral flexible extension of ribbon form which bears lead-in conductors for the heating element and terminals for connecting current supply lines to such lead-in conductors.
18. An assembly according to claim 17, wherein said flexible support member is constituted by a polyester foil.
19. An assembly according to claim 17 or 18, wherein said heating element is printed onto said flexible support member.
20. An assembly according to any of claims 17 to 19, wherein said flexible support member carries a temperature sensor.

21. An assembly according to any of claims 17 to 20, wherein such ribbon extension carries a temperature sensor.

22. An assembly according to any of claims 17 to 21, wherein said flexible support member is constituted as a laminate of two foils 5 with the electrical components sandwiched between them.

23. An assembly according to any of claims 17 to 21, wherein the conductive elements applied to said flexible support member are overcoated with a varnish.

24. An assembly according to any of claims 17 to 23, wherein 10 such ribbon extension is between 5 and 20 centimetres in length.

25. An assembly according to any of claims 17 to 24, wherein the flexible support member is provided with re-entrants in its profile and/or with perforations.

**SB**  
**Patents Act 1977**  
**Examiner's report to the Comptroller under**  
**Section 17 (The Search Report)**

**Application number**

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Relevant Technical fields		Search Examiner
(i) UK CI (Edition )	K H5H; HAP4, HAPX, HAG, HAX2, HBA1, HBA2	R W BALDOCK
(ii) Int CI (Edition ) <sub>5</sub>	H05B 3/04, 3/06, 3/36, 3/84	
<b>Databases (see over)</b>		Date of Search
(i) UK Patent Office		
(ii) ONLINE DATABASES WPI ; EDOC		10 January 1991

**Documents considered relevant following a search in respect of claims**

1-10, 17-25

Category (see over)	Identity of document and relevant passages		Relevant to claim(s)
X	GB 1523129	(HEAT TRACE), see especially page 2 lines 11-73	17-20 22, 23
Y	EP 0334824 A	(KANTHAL), see especially claim 1 lines 14-21	2, 8, 18, 22
X	EP 0295351 A	(BEAUFEREY), see especially figure 1	1-4, 8, 9 17-20, 22
X	US 4665304	(SPENCER), see especially claim 3 line 48 - claim 4 line 17 and claim 5	1-4, 8, 9 17-20, 22
X	US 4665302	lines 1-25 (STANDARD TELEFON), see especially claim 1 lines 61-65 claim 2	23, 25 17-20, 22
		lines 12-14	23, 25

Category	Identity of document and relevant passages	Relevant to claim(s)

#### Categories of documents

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